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(54) **A baffle for a heat exchanger**

(57) A method for forming an internal, integral baffle for a tube and fin type heat exchanger is disclosed. The baffles are formed by plastically deforming a top wall (50) of the manifold against the bottom wall (52) of the manifold to form a depression (58). A slit (59) is formed in the depression, the slit (59) allowing a bonding agent to secure the top wall (50) to the bottom wall (52) to secure the baffle within the manifold.

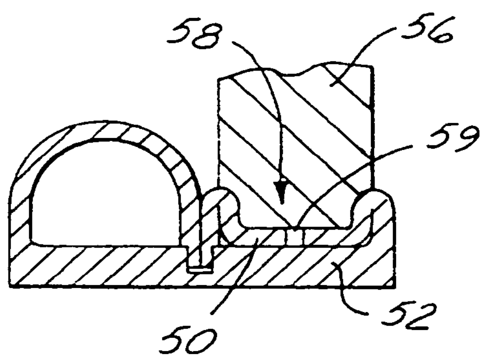

FIG.8

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Description

The present invention relates generally to heat exchangers used in automotive air conditioning systems, such as condensers, evaporators and oil coolers. More particularly, the present invention relates to a method for forming an internal, integral baffle in a heat exchanger.

Reference is made to co-pending U.S. Patent applications "Heat Exchanger Manifold," Serial No. 08/739562 and "A Heat Exchanger," Serial No. 08/739636.

Fin and tube type heat exchangers are commonly used in vehicle, industrial and residential environments for heating and cooling purposes. Typically, these heat exchangers utilise a plurality of tubes through which the fluid to be heated or cooled passes. The number of tubes utilised depends on the thermal capacity requirements of the fin and tube heat exchanger. In order to connect these tubes together so that the fluid can flow through the tubes, manifolds are used having a series of openings corresponding to and mating with the ends of the tubes. The manifolds have an inlet port and an outlet port which circulate the fluid through the heat exchanger and then returns the fluid to a remote location for subsequent recycling.

In multipass heat exchangers, the heat exchanger fluid makes multiple passes through the heat exchanger to increase its efficiency. These multiple passes are accomplished by obstructing the fluid flow at key locations and forcing the fluid across the heat exchanger. Typically, the obstructions are baffles placed within the manifold. Several methods are known for placing baffles within a manifold. In one method, a circular disk of material is place within a predefined aperture in the manifold and welded there. In another method, such as disclosed in U.S. Patent No. 5,090,477 a baffle is mechanically formed by crimping the manifold so that one portion of the manifold wall contacts an opposite portion of the manifold wall. The '477 patent teaches that because of the plastic deformation of the manifold wall, a leak tight seal is formed and brazing is not required further secure the baffle within the manifold. However, if the manifold is used on a heat exchanger requiring extremely high internal pressures, the baffle may leak. Therefore it would be advantageous to provide a manifold with an internally formed baffle that can withstand high pressures.

It is a feature of the present invention that manifolds with internally formed baffles can withstand higher operating pressures with no leaking.

The present invention overcomes the difficulties and deficiencies associated with prior art devices by providing a method of forming internal, integral baffles at baffle locations in a heat exchange manifold, comprising the steps of permanently collapsing the manifold at the baffle locations such that the manifold wall top and the manifold wall bottom form a generally U-shaped depression in the manifold and forming a slit in the U-shaped depression. The method further includes the steps of applying a brazing material to the manifold, causing the brazing material to flow through the slit and between the manifold wall top and manifold wall bottom and processing the manifold at predetermined conditions to secure the manifold wall top and bottom together.

The method provides the advantages of a stronger bond strength at the baffle, thus increasing the burst strength of the manifold.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figures 1 and 2 are perspective views of two different tube and fin heat exchangers including baffles structured in accord with the principles of the present invention;
Figure 3 is a perspective, enlarged view of a portion of Figure 1 showing a baffle of the present invention;
Figure 4 is a cross-sectional view of the baffle of Figure 1 taken along line 4-4;
Figure 5 is a cross-sectional view of Figure 4 taken along line 5-5;
Figure 6 is a perspective view of a tool used in fabricating a baffle in accord with the principles of the present invention;
Figure 7 is a perspective view of a tool used in fabricating a baffle in accord with the principles of the present invention; and
Figure 8 is a cross-sectional view of Figure 7 taken along line 8-8.

Referring now to the drawings, Figures 1 and 2 show two different types of tube and fin heat exchangers 10. Each includes a plurality of tubes 12 with heat dissipative fins 14 interposed between each of the tubes 12. In Figure 1, the heat exchanger includes U-shaped tubes 12 in which the free ends of the tubes matingly engage a manifold 16 disposed at only one end of the heat exchanger 10. As shown in Figure 1, manifold 16 is a double chambered manifold having a first fluid conduit 18 and a second fluid conduit 20. Figure 2 shows a "parallel flow" type of heat exchanger wherein a plurality of generally straight tubes 12' are interposed between a pair of fluid manifolds 16'. Each of the heat exchangers includes an inlet port 22 for receiving fluid therein and an outlet port 24 for discharge of fluid therefrom. As will be explained more fully below, the manifolds 16 and 16' of each type of heat exchanger include a plurality of integrally formed, crimped baffles 26 for directing fluid through the heat exchanger according to a predefined pathway. The baffles 26 of the present invention are essentially the same in each heat exchanger, therefore, the description of the baffles 26 will be made with reference to the heat exchanger of Figure 1. However, it should be apparent that the description of the baffles 26

free ends 17 of the tubes 12 and disposed at one end of the heat exchanger 10. As illustrated, the manifold 16 is a double chambered manifold having a first fluid conduit 18 and a second fluid conduit 20. The first fluid conduit 18 includes an inlet port 22 for receiving fluid therein and the second fluid conduit 20 includes an outlet port 24 for discharge of fluid therefrom. Fluid to be cooled (or heated) enters the manifold 16 through the inlet port 22 and is directed through the tubes 12 wherein the fluid is cooled by a secondary fluid, such as air, passing over the fins 14. Baffles (not shown) in the manifold 16 direct the fluid through the tubes 12 wherein the fluid eventually discharges from outlet port 24. The heat exchanger 10 may include end plates 26 to support the tubes 12 for the manifold 16. It should be appreciated that, except for the manifold 16, the heat exchanger 10 is conventional and known in the art. It should also be appreciated that the manifold 16 could be used for heat exchangers in other applications besides motor vehicles.

Referring to FIGS. 1 and 2, the manifold 16 extends longitudinally. The manifold 16 includes a base member 28 being generally planar and extending laterally. The manifold 16 also includes a plurality of tubular members 30 extending generally perpendicular to the base member 28. The tubular members 30 have a generally circular cross-sectional shape with a fluid passageway 32 extending therethrough and fluidly communicating with the first fluid conduit 18 and the second fluid conduit 20. The tubular members 30 and base member 28 are integral, unitary and formed as one-piece from a metal material such as aluminum. It should be appreciated that the tubular members 30 are secured to the tubes 12 by suitable means such as brazing.

The manifold 16 also includes a first side member 34 along one side of the base member 28. The first side member 34 is generally arcuate in cross-sectional shape. The manifold 16 includes a second side member 36 along the other side of the base member 28 and opposing the first side member 34. The second side member 36 is generally arcuate in cross-sectional shape. The first and second side members 34 and 36 and the base member 28 are integral, unitary and formed as one piece from a metal material such as aluminum. It should be appreciated that the first side member 34 and second side member 36 may have any suitable cross-sectional shape.

The manifold 16 includes at least one, preferably a plurality of folds 38 extending from the base member 28 between a pair of laterally spaced tubular members 30 to form a channel 40. In the embodiment illustrated, two folds 38 are spaced laterally and extend generally perpendicular to and above a plane of the base member 28. Each of the folds 38 extends longitudinally and has a first portion 42 and a second portion 44. Each fold 38 is formed by folding the base member 28 to form the first portion 42 and back on itself to form the second portion 44 to obtain a predetermined fold height. In the embodiment illustrated, the predetermined fold height is approximately 5.5 mm. The folds 38 and base member 28 are integral, unitary and formed as one-piece from a metal material such as aluminum. It should be appreciated that the channel 40 is disposed above the plane of the base member 28.

After the folds 38 are formed, the free ends of the first side member 34 and second side member 36 are disposed in the channel 40 to form the first fluid conduit 18 and second fluid conduit 20, respectively. The manifold 16 has its inner and outer surfaces coated with a known brazing material. As a result, the brazing material flows between the base member 28, folds 38, first side member 34 and second side member 36 by capillary flow action to braze the first side member 34 and second side member 36 and base member 28 together in the channel 40.

Referring to FIGS. 3A through 3D, a method, according to the present invention, of the making the manifold 16 is shown. The method includes the step of providing a generally planar sheet 50 of elongate, deformable material such as aluminum coated with a braze material. The method includes the step of forming the sheet 50 into a base member 28 with tubular members 30 and having the first side member 34 and second side member 36 along a longitudinal length thereof as illustrated in FIG. 3A. The sheet 50 is provided as a stamping. The method includes the step of folding the sheet 50 between the tubular members 30 to form the folds 38 with the first portion 42 and the second portion 44 to a predetermined fold height above a plane of the base member 28 as illustrated in FIG. 3B. The method includes the step of flanging the lateral outer edges of the sheet 50 to form the first side member 34 and second side member 36 as illustrated in FIG. 3C. The method also includes the step of folding or rolling the first side member 34 and second side member 36 toward one another until their free ends are disposed in and meet in the channel 40 to form the first fluid conduit 18 and second fluid conduit 20 as illustrated in FIG. 3D. The free ends of the first side member 34 and second side member 36 are locked or secured in place between the folds 38. The method includes the step of forming ends of the fluid conduits 18 and 20 and assembling adapters into drilled holes in the first and second side members 32 and 34 to form the inlet 22 and outlet 24. The method includes the step of brazing the manifold 16 by heating the manifold 16 to a predetermined temperature to melt the brazing material to braze the base member 28, folds 38, first side member 34 and second side member 36 together and cooling the manifold 16 to solidify the molten braze material to secure the base member 28, folds 38, first side member 34 and second side member 36 together.

Referring to FIG. 4, another embodiment 116, according to the present invention, of the manifold 16 is shown. Like parts of the manifold 16 have like reference numerals increased by one hundred (100). In this embodiment, the free ends of the first side member 134 and second side member 136 have side margins or edges 152 and 154, respectively, of a thickness less than a thickness of a remainder thereof. The side edges 152 and 154 are disposed in the channel 140. The side edges 152 and 154 allow the channel 140 to have a width less than the width of the remainder or original thickness of both side members 134 and 136. The side edges 152 and 154 may be formed by laterally compressing the folds 138 after the side members 134 and 136 are disposed therebetween.

Accordingly, the manifold 16 is a cost reduction over current manifolds that are made from a dual extruded tube with tubular members back extruded. The manifold 16 has a sheet with extruded tubular members or risers and is folded and brazed to make the manifold.

The present invention has been described in an illustrative manner. It is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation.

Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.

What is claimed is:

1. A manifold for a heat exchanger comprising:

a base member having a plurality of tubular members for connection to tubes of a heat exchanger;

a plurality of folds disposed between said tubular members to form a channel above a plane of said base member;

a first side member extending from a side edge of said base member;

a second side member extending from another side of said base member and opposing said first side member; and

free ends of said first side member and said second side member being disposed in said channel and secured in place between said folds to define a first fluid conduit and a second fluid conduit.

2. A manifold as set forth in claim 1 wherein said base member, said folds, said first side member and said second side member are integral, unitary and formed as one-piece.

3. A manifold as set forth in claim 1 wherein said folds comprise a first fold and a second fold spaced laterally and extending longitudinally and generally perpendicular to said base member.

4. A manifold as set forth in claim 1 wherein each of said folds has a first portion and a second portion adjacent said first portion and being formed from said base member.

5. A manifold as set forth in claim 1 wherein said first side member and said second side member have a generally arcuate shape.

6. A manifold as set forth in claim 1 wherein said manifold is a stamping.

7. A manifold as set forth in claim 1 wherein said manifold is made from an aluminum sheet.

8. A manifold as set forth in claim 1 wherein said free ends each have a side edge of a thickness less than a thickness of said first side member and said second side member, each side edge being disposed in said channel.

9. A manifold as set forth in claim 8 wherein said channel has a width less than a thickness of both said first side member and said second side member.

10. A method of making a manifold for a heat exchanger comprising the steps of:

providing a generally planar sheet having a base member with a plurality of tubular members for connection to tubes of a heat exchanger;

folding the sheet and forming a plurality of folds between the tubular members to form a channel above a plane of the base member;

folding lateral side edges of the sheet to form a first side member and a second side member opposing each other; and

folding free ends of the first side member and the second side member toward each other and disposing the free ends in the channel to define a first fluid conduit and a second fluid conduit.

11. A method as set forth in claim 10 including the step of securing the free ends in the channel.

12. A method as set forth in claim 11 wherein said step of securing comprises brazing.

13. A method as set forth in claim 10 wherein said step of forming the folds comprises folding the sheet and forming a first portion and folding the sheet back on itself to form a second portion.

14. A method as set forth in claim 10 wherein said step of folding lateral side edges comprises flanging the lateral side edges of the sheet to form a first side member and a second side member opposing each other.

15. A method as set forth in claim 10 wherein said step of folding free ends comprises rolling the free ends of the first side member and the second side member toward each other and disposing the free ends in the channel to define a first fluid conduit and a second fluid conduit.

16. A method as set forth in claim 10 wherein said step of providing comprises providing a stamped planar sheet having a base member with a plurality of tubular members for connection to tubes of a heat exchanger.

17. A method as set forth in claim 10 including the step of forming the free ends of the first side member and second side member with a side edge of a thickness less than a thickness of the first side member and the second side member.

18. A method as set forth in claim 17 including the step of disposing each side edge of the free ends in the channel.

19. A method as set forth in claim 17 including the step of forming the channel with a width less than a thickness of both the first side member and the second side member.

20. A method as set forth in claim 10 including the step of compressing the folds and free ends of the first side member and second side member.

* * * * *

and the method of forming such baffles applies equally as well to the parallel flow heat exchanger of Figure 2.

In accordance with principles well known in the heat exchanger art, fluid to be cooled (or heated) enters manifolds 16 through inlet port 22 and is directed through the plurality of U-shaped tubes 12 wherein the fluid is cooled by a secondary fluid, such as air, passing over the fins 14. The baffles 26 and the manifold 16 direct the fluid through the U-shaped tubes wherein the fluid eventually discharges from outlet port 24. It should be apparent to those skilled in the art that the heat exchanger of Figure 1 utilises a manifold having a pair of longitudinal fluid conduits although the present invention may be utilised in conjunction with a manifold having a single fluid conduit. As shown in Figure 1, the heat exchanger is a condenser, although the principles of the present invention can be applied to other types of heat exchangers as well.

The manifold 16 is fabricated from an extruded aluminium alloy such as SAE 3003, 3102, or 6062 or any of another of known types of deformable materials. The manifold 16 can be formed according to any of a number of known methods. For example, one such method is taught in U.S. Patent No. 5,190,101, assigned to the assignee of the present invention, the disclosure of which is hereby incorporated by reference. The manifold 16 must include a fluid conduit 18, 20 (Figure 3) as well as fluid conducting passages which matingly engage the tube ends so that fluid can flow through the plurality of tubes. One type of fluid-conducting passage is formed as a plurality of apertures or raised fluid pipes. These passages communicate with the fluid conduits 18, 20 of the manifold 16.

After the fluid conduits and passages have been formed, the baffles 26 are then mechanically crimped into each of the fluid conduits 18, 20 according to a predefined location to achieve the desired circulation of fluid. The crimping operation may be achieved in any of a number of known mechanical processes and one such process is shown in Figures 6-8. The fluid conduits 18, 20, define an arcuate top wall 50 and a bottom wall 52. The manifold is placed into a die 54 in which it is securely held. A vertically reciprocating punch 56 having a slit producing member 60 on an end thereof is forced into the top wall 50 of the conduit until the punch plastically deforms the top wall 50 to the bottom wall 52 to form a depression 58 having a slit 59 therein. As shown in Figure 8, the depression 58 is generally U-shaped and includes the slit 59 therein. In either method, an integrally formed baffle is created.

After the baffles have been formed and the ends of the manifold have been crimped, the manifold assembly is washed in a degreasing solution. From there, the inlet port 22 and outlet port 24 are formed and assembled to the manifold according to known manufacturing processes. The manifold is coated with a brazing material which typically includes a fluxing agent. The brazing material can be in the form of a paste or a wire which is placed along the longitudinal length of the manifold 48 and in the depressions 58. The manifold assembly is then placed in a brazing oven to form a weld seam or brazed joint along the longitudinal length of the manifold as shown at 48 in Figure 4 between each of the fluid conduits 18 and 20. As shown in Figures 4 and 5, during this step, the molten flux/braze material 66 flows through the slits 59 by capillary flow to bond the top wall 50 to the bottom wall 52 of the manifold. By actively bonding the top and bottom walls together, a stronger baffle is formed than without the bonding. This increases the burst strength of the manifold over mechanical crimps alone, and reduces leakage at the baffle. The transverse ends of the fluid conduits are also sealed at this point in the process. The ends may also include a slit for the same purpose as explained above.

After the manifold has been manufactured according to the above process, the U-shaped tubes are connected to the manifold 16. The free ends of the U-shaped tube of the heat exchanger matingly engage fluid passage apertures of the manifold. Fins 14 and end plates 62 complete the assembly. Solder joints are formed at each fluid passage to ensure a leak-free, secure joining of the manifold to the U-shaped tube ends. The manifold may be joined to the heat exchanger in any of a number of known processes such as by vacuum brazing, controlled atmosphere brazing or welding the manifold thereto.

In view of the above, variations and modifications to the present invention will no doubt occur to those skilled in the art. For example, the method of manufacturing the manifold from a single extruded piece of aluminium can also be performed for a single manifold as well as a double manifold. Various other materials may also be chosen to fabricate the manifolds and the present invention is not meant to be limited solely to those specified above.

Claims

1. A method for forming an internal baffle between the ends of a substantially rigid tube comprising the steps of:

    deforming a section of the tube wall (50) toward an opposing section of tube wall (52) until said one section abuts said opposing section;
    forming a slit (59) in one of said sections of the tube wall;
    applying a brazing material (66) to the tube;
    causing the brazing material (66) to flow through the slit (59) and between the abutting sections; and
    processing the tube at predetermined conditions to secure said sections to one another.

2. A method of forming internal, integral baffles at baf-

fle locations in a manifold for use in a heat exchanger, comprising the steps of:

permanently collapsing the manifold at the baffle locations such that the manifold wall top and the manifold wall bottom form a generally U-shaped depression in the manifold;
forming a slit in the U-shaped depression;
applying a brazing material to the manifold;
causing the brazing material to flow through the slit and between the manifold wall top and manifold wall bottom; and
processing the manifold at predetermined conditions to secure said manifold wall top and bottom together.

3. A method according to claim 2, wherein the collapsing step is carried out by contacting the manifold wall top with a punch and applying a force thereto.

4. A method according to claim 2, wherein the step of forming a slit in one of the manifold walls comprises the step of applying a punch having a slit producing end against the manifold wall top until the slit producing end contacts the manifold wall bottom.

5. A method according to claim 2, wherein the deforming step forms a substantially U-shaped internal seam of double wall thickness.

6. A method according to claim 2, wherein the step of causing the brazing material to flow through the slit is carried out by capillary flow.

7. A method according to claim 2, wherein said processing step is carried out in a controlled atmosphere brazing furnace.

8. A method according to claim 2, further including the step of applying a fluxing material prior to applying the brazing material.

9. A method according to claim 2, wherein the brazing material includes a fluxing agent.

10. A method according to claim 2, wherein said internal baffles are formed in a tube for use in an automotive condenser.

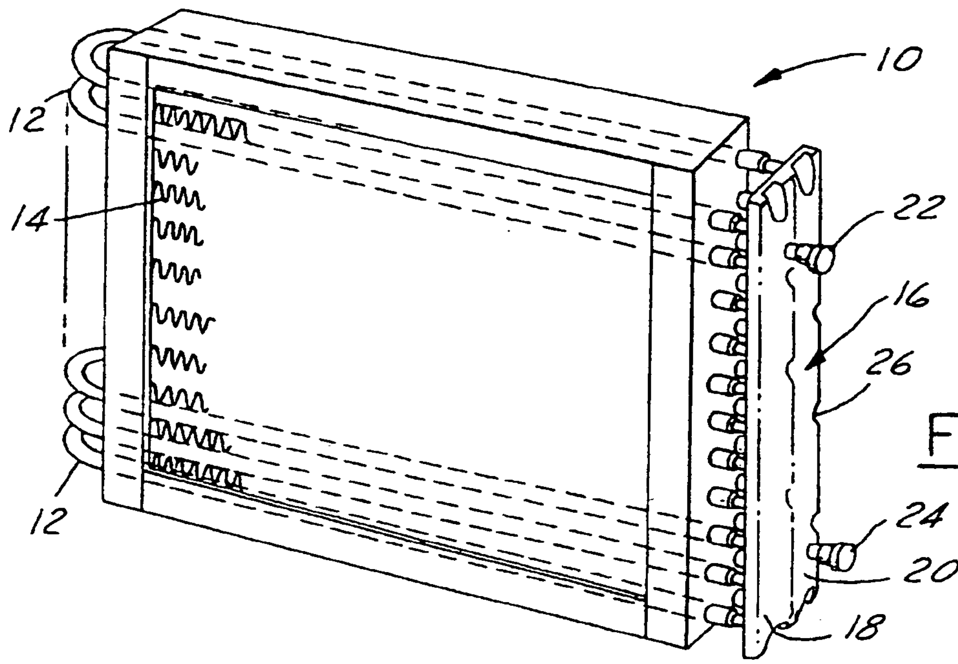

FIG. 1

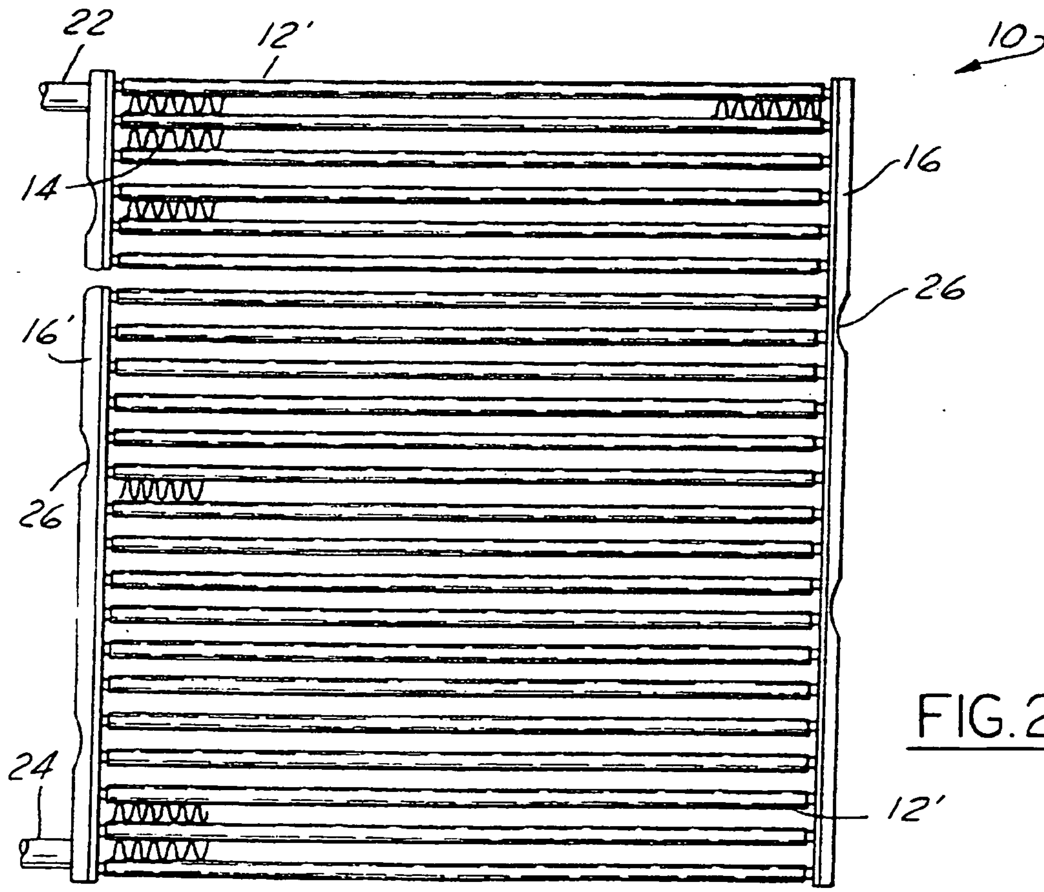

FIG. 2

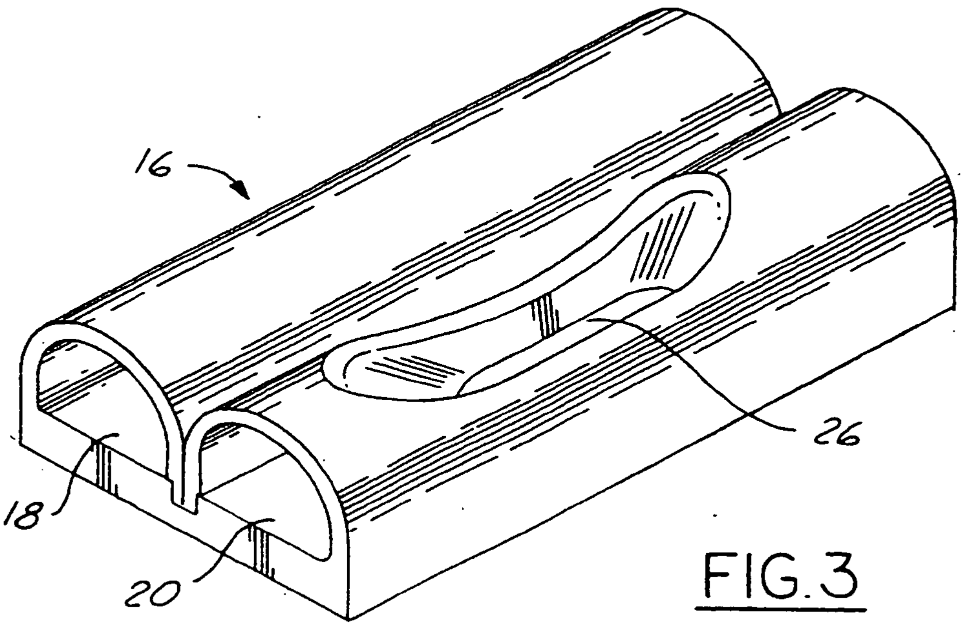

FIG.3

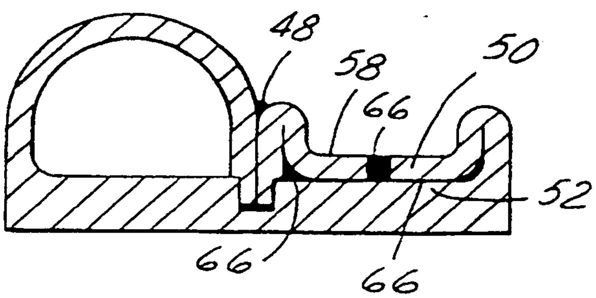

FIG.4

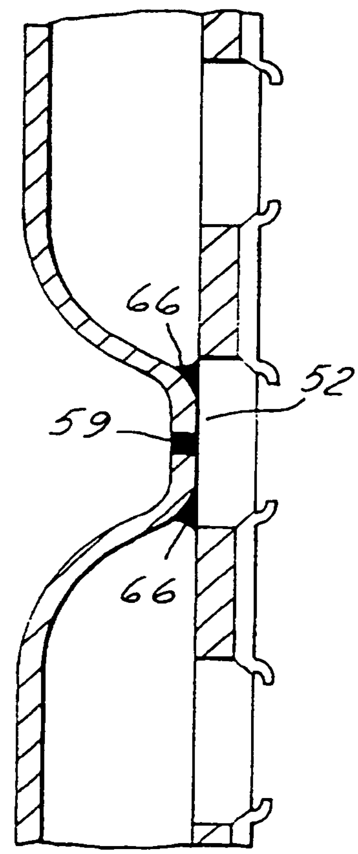

FIG.5

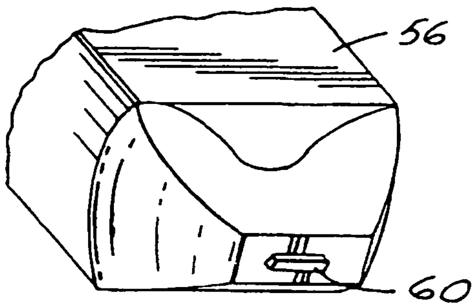

FIG.6

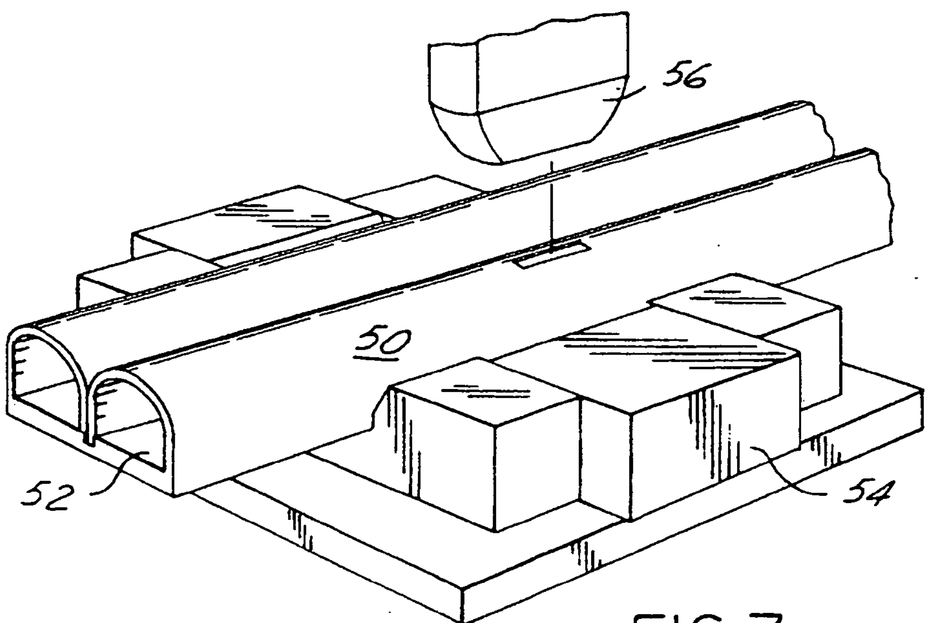

FIG.7

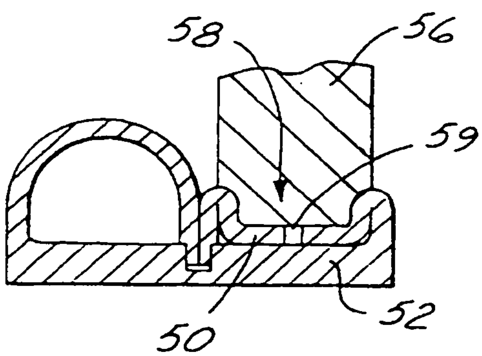

FIG.8